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QUARTERLY REPORT NO. 4

Period: March 1, 1963 to May 31, 1963

FABRICATION OF PROTOTYPE
ROCKET MOTOR CASE BY
CRYOGENIC STRETCH-FORMING

Prepared Under:

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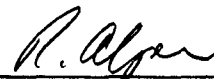

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1.0 OBJECTIVE

The objective of this program is to produce experimental flightweight rocket motor cases of the Sparrow configuration by the cryogenic stretch-forming process.

Achievement of B/P dimensions and determination of the suitability of the cryogenic stretch-forming process for production are the specific aims of the program.

2.0 SUMMARY

Previous quarterly reports indicated that techniques were being developed to achieve B/P dimensions in several areas of the Sparrow Motor Case. These areas included dimensional deviations in the contour of the hemispherical segment of the aft closure and the diameter of the forward thickened ring. Both of these problems have been solved during this report period.

Fabrication of the nozzle end ring presented a problem because of material springback during the mechanical stretch by a punch. During this report period, the feasibility of this method of fabrication of heavy rings was demonstrated, although one dimension was not achieved.

3.0 WORK ACCOMPLISHED

3.1 Fabrication

Five Sparrow-size spheres and three Sparrow preforms were fabricated during this report period.

The spheres were built to obtain cryogenic-stretch pressure data applicable to the hemispherical aft segment. A Sparrow preform stretch pressure which would result in proper Sparrow finished dimensions could be deduced from the sphere data.

3.1 (Cont'd)

Two of the three Sparrow preforms were built to verify the information obtained from the spheres. The third preform was built as a result of experience gained from the two preforms. The first two preforms were designed with a hemispherical head of AISI 304L material on one end, and a head of AISI 302 material on the other end. In addition, each preform was built to a different diameter. Since each preform was capable of making two finished Sparrows, a total of four possible combinations was realized for evaluation. One of these preforms burst along the longitudinal weld, while being stretched cryogenically, at a pressure of 3300 psi. One end of this preform was found to be intact. It was therefore decided to salvage it by removing the damaged portion and incorporating a new hemispherical head. The salvaged preform half was then cryogenically burst in the same manner as the original preform at a pressure of 4050 psi. The second preform was successfully stretched and machined into two finished Sparrow motor cases.

3.2 Dimensional Control

3.2.1 Hemispherical Segment, Aft Closure

As reported in the previous progress report, several approaches were being taken in meeting B/P dimensions in the hemispherical-segment area of the Sparrow Motor Case. This problem was evaluated by the five Sparrow-size spheres and the Sparrow preforms fabricated. Each of the sphere preforms was marked with concentric diametral rings located at various distances from pole to equator and crossed by meridians. Preform dimensions were then taken at these markings. The first, second and third

3.2.1 (Cont'd)

spheres were stretched to 4000, 4500 and 5000 psig; the fourth and fifth spheres burst at a pressure of 5500 psig, thus establishing an upper limit for Sparrow pressurization. By remeasuring the sphere markings after stretch and performing an engineering evaluation, it was estimated that the first Sparrow preform--which had a diameter equal to .044" greater than previous Sparrow preforms, and was designated as Serial No. 826--should be cryogenically stretched to 4500 psig in order to obtain proper hemispherical dimensions. This preform, unfortunately, burst in the stretch pit as reported under Paragraph 3.1.

It was then decided to stretch the second Sparrow preform--which incorporated a diameter .120" larger than previously stretched Sparrow preforms, and was designated as Serial No. 825--to 5000 psi cryogenically. This represented an overpressure of 500 psi over that thought necessary for proper stretching and 500 psi below the maximum pressure to which the preform should be subjected, based on the sphere data obtained. This vessel survived the overpressure, and hemispherical heads were within acceptable Sparrow dimensions. The hemispherical contour problem has thus been solved.

3.2.2 Forward Thickened Ring

The forward thickened ring had failed to meet O.D. requirements when designed to a thickness of .140" utilizing AISI 304L material and cryogenically stretched to a pressure of 5400 psi. In an attempt to rectify this condition, the die in which the Sparrow preforms are

3.2.2 (Cont'd)

stretched was modified by incorporating relief holes in the area in which the thickened ring lies. It was also decided to substitute an AISI 302 material for the thickened ring and to change its thickness to .120". With a cryogenic-stretch pressure of 4500 psi, the ring section stretched to the proper O.D., but due to its thinner cross-section, was unable to meet I.D. dimensions. It was then decided to try stretching the .140"-thick AISI 304L material again in the modified Sparrow die. Preform Vessel S/N 825, which incorporated this ring, was stretched successfully and met both I.D. and O.D. requirements. This indicates that the dimensional problems in this area have been solved.

3.2.3 Nozzle End Ring

As reported in the previous quarterly report, tooling for mechanically stretching the AISI 301 stainless-steel nozzle housing at cryogenic temperatures was completed; however, difficulty was being encountered in its use due to material springback. The die was further modified, and five nozzle end rings were cryogenically stretched. The feasibility of the process was demonstrated, although the 6.125/6.123 diameter cannot be met along its entire length. Expense and time required for designing and fabricating of a new stretch die to rectify this condition preclude its manufacture.

3.3 Hydrotest

Two completed Sparrow rocket motor cases, serialized as 825-1 and 825-2, were hydrotested to B/P requirements of 1870 \pm 10 psi for three minutes, with suitable test equipment,

3.3 (Cont'd)

at the Paramus Hydrotest facility. Both vessels were instrumented with SR-4 strain gages at strategic locations. No evidence of yielding at strain-gage locations was observed.

Photographs of one of the finished Sparrow cases, showing hydrotest end closures, strain gages, and hydrotest equipment, are shown in Figs. 1, 2 and 3.

4.0 WORK PROJECTED

- 4.1 Fabricate one additional Sparrow Motor Case and hydrotest to B/P requirements.
- 4.2 Final-inspect two finished Sparrow Motor Cases and deliver to destination.
- 4.3 Complete final report on the program.

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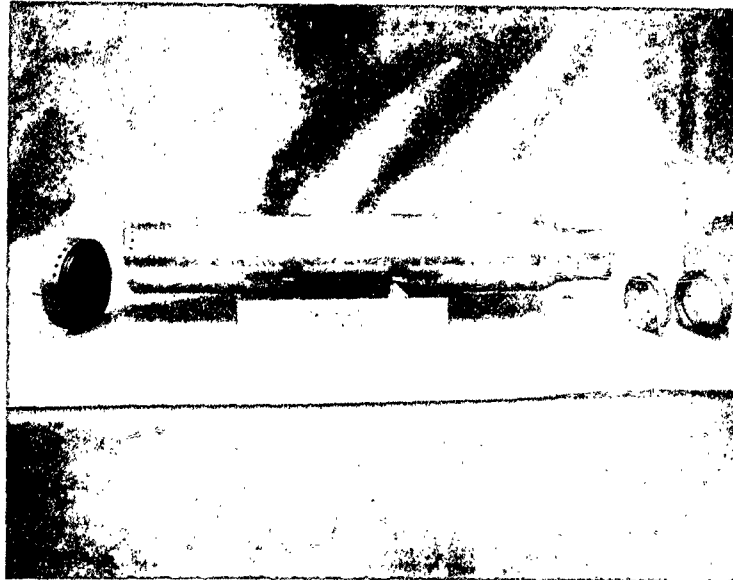


Fig. 1 - ARDEFORMED Sparrow Motor Case
with hydrotest end caps.

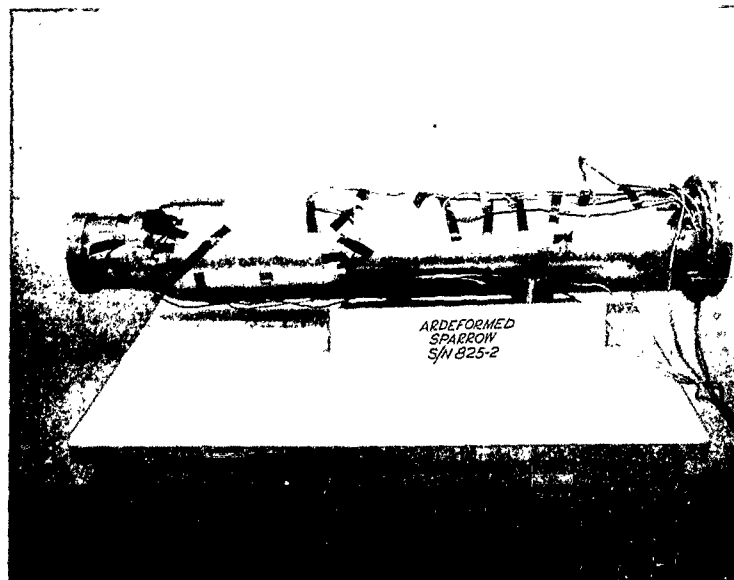


Fig. 2 - ARDEFORMED Sparrow Motor Case
with strain gages attached
ready for hydrotest.



Fig. 3 - Hydrotest facility showing
ARDEFORMED Sparrow Motor Case
ready for test.